

1 **CLAIMS:**

2 1. A method of forming a non-volatile resistance variable
3 device, comprising:

4 forming a first electrode over a substrate;

5 forming a dielectric layer over the first electrode;

6 forming an opening having sidewalls into the dielectric layer to
7 the first electrode in a manner which produces at least one surface
8 striation in at least a portion of the opening sidewalls;

9 forming voltage or current controlled resistance setable
10 semiconductive material within the opening in electrical connection with
11 the first electrode, said material having a surface at least a portion of
12 which extends along the at least one dielectric layer striation to form
13 at least one surface striation in the surface portion; and

14 forming a second electrode in electrical connection with the
15 voltage or current controlled resistance setable semiconductive material
16 received within the opening.

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18 2. The method of claim 1 comprising forming the non-volatile
19 resistance variable device into a programmable memory cell of memory
20 circuitry.

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22 3. The method of claim 1 comprising forming the non-volatile
23 resistance variable device into an antifuse of integrated circuitry.

1 4. The method of claim 1 comprising forming the non-volatile
2 resistance variable device into a programmable resistance element of
3 integrated circuitry.

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5 5. The method of claim 1 comprising forming the non-volatile
6 resistance variable device into a programmable capacitance element of
7 integrated circuitry.

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9 6. The method of claim 1 comprising forming the non-volatile
10 resistance variable device into a programmable optical element of
11 integrated circuitry.

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13 7. The method of claim 1 comprising forming the non-volatile
14 resistance variable device into a programmable metallization cell.

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16 8. The method of claim 1 comprising forming the non-volatile
17 resistance variable device into an analog memory device capable of
18 being set and reset to a resistance value over a continuous range of
19 resistance values which is a measure of a voltage applied to it over a
20 corresponding range of voltage values.

21
22 9. The method of claim 1 comprising forming a plurality of the
23 surface striations in the opening sidewalls and the surface portion.

1 10. The method of claim 1 comprising forming the at least one
2 sidewall striation and the at least one surface portion striation to extend
3 from proximate the first electrode to proximate the second electrode.

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5 11. The method of claim 1 comprising forming the at least one
6 sidewall striation and the at least one surface portion striation to extend
7 in a substantially straight line.

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9 12. The method of claim 1 comprising forming the at least one
10 sidewall striation and the at least one surface portion striation to extend
11 in a substantially straight line from proximate the first electrode to
12 proximate the second electrode.

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14 13. The method of claim 1 comprising forming the at least one
15 sidewall striation and the at least one surface portion striation to extend
16 in a substantially straight line of least possible distance from proximate
17 the first electrode to proximate the second electrode.

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19 14. The method of claim 1 comprising forming the at least one
20 surface portion striation to contact the dielectric layer.

1 15. The method of claim 1 wherein the forming of the opening
2 in the dielectric layer comprises etching, the manner comprises forming
3 at least one surface striation in a sidewall of a masking layer opening
4 overlying the dielectric layer, and etching into the dielectric layer to
5 form the dielectric layer opening using the masking layer as an etching
6 mask.

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8 16. The method of claim 1 wherein the forming of the opening
9 in the dielectric layer comprises etching, and the manner comprises
10 forming the at least one sidewall striation during initial dielectric layer
11 etching to form the opening.

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13 17. The method of claim 1 wherein the forming of the opening
14 in the dielectric layer comprises etching, and the manner comprises
15 forming the at least one sidewall striation after dielectric layer etching
16 to the first electrode.

1 18. A method of forming a non-volatile resistance variable
2 device, comprising:

3 forming a first electrode over a substrate;

4 forming a dielectric layer over the first electrode;

5 forming an opening having sidewalls into the dielectric layer to
6 the first electrode in a manner which produces at least one surface
7 striation in at least a portion of the opening sidewalls;

8 forming a fast ion conductor material within the opening in
9 electrical connection with the first electrode, said material having a
10 surface at least a portion of which extends along the at least one
11 dielectric layer striation to form at least one surface striation in the
12 surface portion; and

13 forming a second electrode in electrical connection with the fast
14 ion conductor material received within the opening.

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16 19. The method of claim 18 wherein the fast ion conductor
17 material comprises metal ion-containing dielectric material.

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19 20. The method of claim 18 wherein the fast ion conductor
20 material comprises metal ion-containing semiconductive material.

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22 21. The method of claim 18 comprising forming a plurality of
23 the surface striations in the opening sidewalls and the surface portion.

1 22. The method of claim 18 comprising forming the at least one
2 sidewall striation and the at least one surface portion striation to extend
3 from proximate the first electrode to proximate the second electrode.

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5 23. The method of claim 18 comprising forming the at least one
6 sidewall striation and the at least one surface portion striation to extend
7 in a substantially straight line.

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9 24. The method of claim 18 comprising forming the at least one
10 sidewall striation and the at least one surface portion striation to extend
11 in a substantially straight line from proximate the first electrode to
12 proximate the second electrode.

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14 25. The method of claim 18 comprising forming the at least one
15 sidewall striation and the at least one surface portion striation to extend
16 in a substantially straight line of least possible distance from proximate
17 the first electrode to proximate the second electrode.

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19 26. The method of claim 18 comprising forming the at least one
20 surface portion striation to contact the dielectric layer.

1 27. The method of claim 18 wherein the forming of the opening
2 in the dielectric layer comprises etching, the manner comprises forming
3 at least one surface striation in a sidewall of a masking layer opening
4 overlying the dielectric layer, and etching into the dielectric layer to
5 form the dielectric layer opening using the masking layer as an etching
6 mask.

7
8 28. The method of claim 18 wherein the forming of the opening
9 in the dielectric layer comprises etching, and the manner comprises
10 forming the at least one sidewall striation during initial dielectric layer
11 etching to form the opening.

12
13 29. The method of claim 18 wherein the forming of the opening
14 in the dielectric layer comprises etching, and the manner comprises
15 forming the at least one sidewall striation after dielectric layer etching
16 to the first electrode.

1 30. A method of forming an analog memory device capable of
2 being set and reset to a resistance value over a continuous range of
3 resistance values which is a measure of a voltage applied to it over a
4 corresponding range of voltage values, said method comprising:

5 forming a first electrode over a substrate;

6 forming a dielectric layer over the first electrode;

7 forming an opening having sidewalls into the dielectric layer to
8 the first electrode in a manner which produces at least one surface
9 striation in at least a portion of the opening sidewalls;

10 forming a material exhibiting said range of resistance values within
11 the opening in electrical connection with the first electrode, said
12 material having a surface at least a portion of which extends along the
13 at least one dielectric layer striation to form at least one surface
14 striation in the surface portion; and

15 forming a second electrode in electrical connection with the
16 voltage or current controlled resistance setable semiconductive material
17 received within the opening.

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19 31. The method of claim 30 comprising forming the at least one
20 sidewall striation and the at least one surface portion striation to extend
21 from proximate the first electrode to proximate the second electrode.

1 32. The method of claim 30 comprising forming the at least one
2 sidewall striation and the at least one surface portion striation to extend
3 in a substantially straight line.

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5 33. The method of claim 30 comprising forming the at least one
6 sidewall striation and the at least one surface portion striation to extend
7 in a substantially straight line from proximate the first electrode to
8 proximate the second electrode.

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10 34. A method of forming a programmable memory cell
11 comprising providing a body formed of a voltage or current controlled
12 resistance setable material, and providing at least two spaced electrodes
13 on the body, the body comprising a surface extending from one of the
14 electrodes to the other of the electrodes, the surface being formed to
15 comprise at least one surface striation extending from proximate the one
16 electrode to proximate the other electrode at least when the body of
17 said material is in a highest of selected resistance setable states.

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19 35. The method of claim 34 wherein the voltage or current
20 controlled resistance setable material comprises semiconductive material.

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22 36. The method of claim 34 wherein the voltage or current
23 controlled resistance setable material comprises metal ion-containing
24 semiconductive material.

1 37. The method of claim 34 wherein the voltage or current
2 controlled resistance setable material comprises metal ion-containing
3 dielectric material.

4

5 38. The method of claim 34 comprising forming the at least one
6 striation to extend in a substantially straight line.

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8 39. The method of claim 34 comprising forming the at least one
9 striation to extend in a substantially straight line of least possible
10 distance from proximate the one electrode to proximate the other
11 electrode.

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13 40. A method of forming a non-volatile resistance variable
14 device comprising providing a body formed of a voltage or current
15 controlled resistance setable material, and providing at least two spaced
16 electrodes on the body, the body comprising a surface extending from
17 one of the electrodes to the other of the electrodes, the surface being
18 formed to comprise at least one surface striation extending from
19 proximate the one electrode to proximate the other electrode at least
20 when the body of said material is in a highest of selected resistance
21 setable states.

22

23 41. The method of claim 40 wherein the voltage or current
24 controlled resistance setable material comprises semiconductive material.

1 42. The method of claim 40 wherein the voltage or current
2 controlled resistance setable material comprises metal ion-containing
3 semiconductive material.

4
5 43. The method of claim 40 wherein the voltage or current
6 controlled resistance setable material comprises metal ion-containing
7 dielectric material.

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9 44. The method of claim 40 comprising forming the at least one
10 striation to extend in a substantially straight line.

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12 45. The method of claim 40 comprising forming the at least one
13 striation to extend in a substantially straight line of least possible
14 distance from proximate the one electrode to proximate the other
15 electrode.

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1 46. A method of structurally changing a non-volatile device
2 having a body formed of a voltage or current controlled resistance
3 setable material and at least two spaced electrodes on the body, with
4 the body comprising a surface extending from one of the electrodes to
5 the other of the electrodes, and with the surface being formed to
6 comprise at least one surface striation extending from proximate the one
7 electrode to proximate the other electrode, the method comprising
8 applying a first voltage between the one and the other electrodes to
9 establish a negative and a positive electrode effective to form a
10 conductive path formed of at least some material derived from the
11 voltage or current controlled resistance setable material and on the
12 surface along at least a portion of the at least one striation.

13
14 47. The method of claim 46 comprising after applying the first
15 voltage, applying a second voltage opposite in polarity to the first
16 voltage to reverse formation of the conductive path.

17
18 48. The method of claim 46 comprising after applying the first
19 voltage, applying a sufficiently high current to break the conductive
20 path.

1 49. A method of shorting a non-volatile device having a body
2 formed of a voltage or current controlled resistance setable material and
3 at least two spaced electrodes on the body, with the body comprising
4 a surface extending from one of the electrodes to the other of the
5 electrodes, and with the surface being formed to comprise at least one
6 surface striation extending from proximate the one electrode to
7 proximate the other electrode, the method comprising applying a first
8 voltage between the one and the other electrodes to establish a negative
9 and a positive electrode effective to form a conductive path formed of
10 at least some material derived from the voltage or current controlled
11 resistance setable material and on the surface along the at least one
12 striation effective to electrically short the one and the other electrodes.

13
14 50. The method of claim 49 comprising after applying the first
15 voltage, applying a second voltage opposite in polarity to the first
16 voltage to reverse formation of the conductive path.

17
18 51. The method of claim 49 comprising after applying the first
19 voltage, applying a sufficiently high current to break the conductive
20 path.

1 52. A non-volatile resistance variable device, comprising:
2 a substrate having a first electrode formed thereover;
3 a dielectric layer received over the first electrode;
4 an opening having sidewalls extending through the dielectric layer
5 to the first electrode, the sidewall having at least one surface striation
6 in a portion thereof;

7 a voltage or current controlled resistance setable semiconductive
8 material received within the opening in electrical connection with the
9 first electrode, said material having a portion received on the sidewall
10 surface striation; and

11 a second electrode in electrical connection with the voltage or
12 current controlled resistance setable semiconductive material received
13 within the opening.

14

15 53. The device of claim 52 wherein the at least one sidewall
16 striation extends in a substantially straight line.

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18 54. The device of claim 52 wherein the at least one sidewall
19 striation extends from proximate the first electrode to proximate the
20 second electrode.

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22 55. The device of claim 52 wherein the at least one sidewall
23 striation extends in a substantially straight line from proximate the first
24 electrode to proximate the second electrode.

1 56. The device of claim 52 wherein the at least one sidewall
2 striation extends in a substantially straight line of least possible distance
3 from proximate the first electrode to proximate the second electrode.

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5 57. A non-volatile resistance variable device, comprising:
6 a substrate having a first electrode formed thereover;
7 a dielectric layer received over the first electrode;
8 an opening having sidewalls extending through the dielectric layer
9 to the first electrode, the sidewall having at least one surface striation
10 in a portion thereof;
11 a fast ion conductor material received within the opening in
12 electrical connection with the first electrode, said material having a
13 portion received on the sidewall surface striation; and
14 a second electrode in electrical connection with the voltage or
15 current controlled resistance setable semiconductive material received
16 within the opening.

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18 58. The device of claim 57 wherein the fast ion conductor
19 material comprises metal ion-containing dielectric material.

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21 59. The device of claim 57 wherein the fast ion conductor
22 material comprises metal ion-containing semiconductive material.

1 60. The device of claim 57 wherein the at least one sidewall
2 striation extends in a substantially straight line.

3
4 61. The device of claim 57 wherein the at least one sidewall
5 striation extends from proximate the first electrode to proximate the
6 second electrode.

7
8 62. The device of claim 57 wherein the at least one sidewall
9 striation extends in a substantially straight line from proximate the first
10 electrode to proximate the second electrode.

11
12 63. The device of claim 57 wherein the at least one sidewall
13 striation extends in a substantially straight line of least possible distance
14 from proximate the first electrode to proximate the second electrode.

1 64. An analog memory device capable of being set and reset
2 to a resistance value over a continuous range of resistance values which
3 is a measure of a voltage applied to it over a corresponding range of
4 voltage values, said device comprising:

5 a substrate having a first electrode formed thereover;
6 a dielectric layer received over the first electrode;
7 an opening having sidewalls extending through the dielectric layer
8 to the first electrode, the sidewall having at least one surface striation
9 in a portion thereof;
10 a material exhibiting said range of resistance values received
11 within the opening in electrical connection with the first electrode, said
12 material having a portion received on the surface striation; and
13 a second electrode in electrical connection with the voltage or
14 current controlled resistance setable semiconductive material received
15 within the opening.

16

17 65. The device of claim 64 wherein the at least one sidewall
18 striation extends in a substantially straight line.

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20 66. The device of claim 64 wherein the at least one sidewall
21 striation extends from proximate the first electrode to proximate the
22 second electrode.

1 67. The device of claim 64 wherein the at least one sidewall
2 striation extends in a substantially straight line from proximate the first
3 electrode to proximate the second electrode.

4
5 68. The device of claim 64 wherein the at least one sidewall
6 striation extends in a substantially straight line of least possible distance
7 from proximate the first electrode to proximate the second electrode.

8
9 69. A programmable memory cell comprising a body formed of
10 a voltage or current controlled resistance setable material, and at least
11 two spaced electrodes on the body, the body comprising a surface
12 extending from one of the electrodes to the other of the electrodes, the
13 surface comprising at least one surface striation extending from
14 proximate the one electrode to proximate the other electrode at least
15 when the body of said material is in a highest of selected resistance
16 setable states.

17
18 70. The cell of claim 69 wherein the voltage or current
19 controlled resistance setable material comprises semiconductive material.

20
21 71. The cell of claim 69 wherein the voltage or current
22 controlled resistance setable material comprises metal ion-containing
23 semiconductive material.

1 72. The cell of claim 69 wherein the voltage or current
2 controlled resistance setable material comprises metal ion-containing
3 dielectric material.

4

5 73. The cell of claim 69 wherein the at least one sidewall
6 striation extends in a substantially straight line.

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8 74. The cell of claim 69 wherein the at least one sidewall
9 striation extends in a substantially straight line of least possible distance
10 from proximate the one electrode to proximate the other electrode.

11

12 75. A non-volatile resistance variable device comprising a body
13 formed of a voltage or current controlled resistance setable material,
14 and at least two spaced electrodes on the body, the body comprising
15 a surface extending from one of the electrodes to the other of the
16 electrodes, the surface comprising at least one surface striation extending
17 from proximate the one electrode to proximate the other electrode at
18 least when the body of said material is in a highest of selected
19 resistance setable states.

20

21 76. The cell of claim 75 wherein the voltage or current
22 controlled resistance setable material comprises semiconductive material.

1 77. The cell of claim 75 wherein the voltage or current
2 controlled resistance setable material comprises metal ion-containing
3 semiconductive material.

4
5 78. The cell of claim 75 wherein the voltage or current
6 controlled resistance setable material comprises metal ion-containing
7 dielectric material.

8
9 79. The cell of claim 75 wherein the at least one sidewall
10 striation extends in a substantially straight line.

11
12 80. The cell of claim 75 wherein the at least one sidewall
13 striation extends in a substantially straight line of least possible distance
14 from proximate the one electrode to proximate the other electrode.